Chapter Four

A Focused Strategy and Alternative Programs for NASA

An alternative to the National Aeronautics and Space Administration's strategy of adjusting to lower future budgets is to radically restructure the agency's program to fit a more limited budget outlook. This chapter outlines three illustrative alternatives to NASA's current program. Each adopts a more focused strategy than the current program by emphasizing one of the major objectives that the agency has historically pursued.

The cost of each alternative is limited to $14.3 billion annually over five years. The Congressional Budget Office (CBO) has developed two of the three alternatives to require lower levels of funding in recognition of the national emphasis on deficit reduction and the prospect of fewer benefits from spending on programs that pursue more limited and narrower objectives than the current program. An implicit cost of each alternative is the potential benefits that each would forgo compared with successfully carrying out the agency's current strategy, which attempts to maintain the broad array of NASA's traditional activities and the benefits that those activities provide.

Program Alternatives

One way to address many of the criticisms of the cost and content of NASA's program is to narrow dramatically the focus of the agency's activities. If one of the agency's problems is trying to do too much with too few dollars, then a solution is to do less. Although the strategy of adjustment that NASA is now pursuing has required that projects be scaled back, delayed, or even canceled, the basic structure of the program has remained intact. The three alternatives that follow share the characteristic of breaking that recent pattern:

- Placing even greater emphasis on piloted spaceflight and exploration, within an annual budget of $14.3 billion;
- Emphasizing space science, including piloted spaceflight for scientific purposes, within an annual budget of $11 billion; and
- Emphasizing technology and missions with commercial potential and science with applications value, and eliminating the piloted spaceflight program, within an annual budget of $7 billion.

The selection of these alternatives is arbitrary, but each emphasizes one of the broad objectives from NASA's current program that the agency has pursued over its 37-year life span. Each alternative would narrow the focus of NASA's activity but would support the emphasized activity more aggressively than the current program, even when the total budget for the agency is smaller. For example, the technology and space science alternative emphasizes aeronautics, funding these activities at $1.5 billion--a 75 percent increase above the 1993 level--although the total NASA budget under this alternative would be only half of its current level. (See Table 5 for a budgetary outline of each alternative and of NASA's 1993 budget, the baseline from which they were developed.)

The alternatives are outlines of different program structures that NASA could adopt, not well-defined program plans. The descriptions of each alternative that follow include only illustrative activ-

Table 5.
National Aeronautics and Space Administration's 1993 Operating Plan and Alternatives
(In millions of dollars of budget authority)

	1993 Operating Plan	Alternatives		
		Piloted Spaceflight	Space Science	Technology and Space Science
Research and Development				
Space station	2,123	3,000	0	0
Space transportation capability	649	650	555	0
Space science and applications				
Physics and astronomy	1,104	400	1,200	450
Planetary exploration	474	800	700	300
Life sciences	140	190	200	0
Microgravity	173	200	200	0
Earth science	864	300	1,200	1,200
Other	111	0	200	200
Subtotal	2,866	1,890	3,700	2,150
Space research and technology	273	900	200	500
Commercial programs	164	0	0	100
Aeronautical research and technology	866	500	500	1,500
Safety, reliability, and quality assurance	33	33	33	33
Academic programs	93	93	93	93
Tracking and data advancement systems	23	23	23	23
Total	7,089	7,089	5,104	4,399
Space Flight, Control, and Data Communications				
Shuttle production and operations capability	1,053	1,053	600	0
Shuttle operations	3,016	3,016	2,800	0
Space and ground tracking systems	836	836	636	500
Launch services	181	181	280	1,000
Total	5,086	5,086	4,316	1,500
Construction of Facilities	525	525	300	285
Research and Program Management	1,615	1,615	1,265	800
Inspector General	15	15	15	15
Total, Operating Plan and Alternatives	14,330	14,330	11,000	7,000

SOURCE: Congressional Budget Office based on data from National Aeronautics and Space Administration, "Operating Plan for 1993" (1993).

NOTE: Numbers may not add to totals because of rounding.

ities taken from the voluminous literature cataloging and recommending activities for the agency. Although the costs of the second and third alternatives are provided as point estimates, their actual costs could vary by perhaps as much as a billion dollars above or below the illustrative estimate.

An actual program plan would include far more detail about the activities NASA would undertake in pursuing an alternative to its current program. An actual plan would also include a transition strategy and budget for personnel, facilities, and projects. As the ongoing adjustment to lower defense spending shows, significant costs are incurred when an agency reduces its work force, closes facilities, or dramatically alters its priorities, as NASA would if it were to carry out any one of the alternatives. The outlines that follow do not include such plans. The outlines also do not include the reformulation of international agreements that would have to take place if NASA's program and budget were substantially reduced.

Piloted Spaceflight and Exploration

This alternative would direct NASA's resources toward piloted spaceflight, concentrating on the space station program and new technology to support future piloted exploration of the solar system. It responds to those critics of the content of NASA's current program who contend that the agency does not give a high enough priority to human exploration of the solar system. Spending for space science and technology activities in areas that do not directly support human exploration would be reduced dramatically under this alternative.

The pace of human exploration activities is likely to be slow, however, as most estimates of the cost of a base on the Moon or a mission to Mars make such activities unaffordable within the budget constraints on this alternative. Even under the best of circumstances, the space station would only become operational late in this decade, and the spending for new technologies to enable future missions might not bear fruit until even later. Nevertheless, reallocating funds to emphasize the objective of piloted spaceflight should build a better foundation for a return to the Moon or a piloted mission to Mars than either of the other alternatives or NASA's current program. Moreover, this alternative would allow the Administration to pursue the foreign policy objective of joint U.S.-Russian development of a space station with more confidence that adequate funding will be available.

Under this alternative, the space station program would receive $3 billion annually, $900 million above the 1993 level. This amount is sufficient to cover the annual cost of any of the three options identified in the space station redesign effort of 1993.[1] Over a five-year period, funding may even be sufficient to include a large centrifuge.[2] Funding for space research and technology would also increase under this alternative from the 1993 level of $270 million to $900 million to permit early development of the launch vehicles and spacecraft necessary for a base on the Moon or a mission to Mars. The ill-fated Space Exploration Initiative proposed by the Bush Administration provides a blueprint for a similarly expanded research agenda.[3] This alternative would decrease funding for aeronautical research and technology from $865 million to $500 million and redirect it to support the development of technology necessary for a transatmospheric vehicle that potentially could play a role in meeting the Earth-to-orbit transportation needs of future piloted exploration. The budget category for the space shuttle and space tracking net-

1. National Aeronautics and Space Administration, "Space Station Redesign Team: Final Report to the Advisory Committee on the Redesign of the Space Station" (June 1993), Table CS-4, provides estimates of the annual funding necessary to build each of the three options evaluated in the report. Peak annual funding is $2.9 billion in two of the options for 1996 but below that level in each option for all other years.

2. The centrifuge is needed to study the effects of varying levels of gravity on mammals and by some accounts is a necessary precursor to a piloted mission to Mars. A cost estimate (about $800 million over seven years) for a centrifuge and experiments is included in General Accounting Office, *Space Station: Program Instability and Cost Growth Continue Pending Redesign* (May 1993), p. 5.

3. See National Aeronautics and Space Administration, *Budget Estimates, Fiscal Year 1989*, pp. RD 15-1 through RD 15-7. NASA's budget request outlines a program of increased spending for space research and technology in justifying its request to increase funding for this activity from $239 million in 1988 to $391 million in 1989.

works--Space Flight, Control, and Data Communications--would be maintained at the 1993 level, anticipating eight shuttle flights per year.

The space science and applications budget that funds activities in astrophysics, planetary exploration, and Earth observation would be reduced from its 1993 level of $2.9 billion to $1.9 billion, its lowest level under any of the three alternatives. This smaller total would be redirected toward robotic missions to support future piloted exploration of the solar system and toward microgravity and life sciences research that would benefit most from having a permanent piloted facility in Earth orbit. Under the planetary exploration program, NASA would probably undertake robotic precursor missions to Mars and a lunar survey mission to facilitate future piloted activities.[4]

This alternative would dramatically change the Earth science and physics and astronomy programs, restricting them to a combined budget only 35 percent as large as the budget for 1993. In particular, the Earth Observation System program would be hard hit. This alternative would restrict even the operation of missions that are currently in orbit--for example, the Compton Gamma Ray Observatory and the Hubble Space Telescope.[5] In sum, planners of space science activities would be forced to pursue the "cheaper, better, quicker" philosophy because tight budgets would preclude the large-scale missions that have recently dominated NASA's activities in this area.

Space Science

The space science alternative would increase funding for this category of projects but at the same time decrease NASA's total funding from $14.3 billion to $11 billion. The total annual cost of this alternative could vary between $10 billion and $12 billion.

This plan emphasizes the creation of new scientific knowledge, including knowledge gained in piloted spaceflight. The mix of programs under this alternative addresses the criticism that NASA's current program places too much emphasis on piloted spaceflight when the agency's major contribution has been--and should be--creating new scientific knowledge.

The level of spending for space science in NASA's 1993 budget was $2.9 billion, but this alternative would increase that figure to $3.7 billion, a jump of 28 percent. Recent budget plans indicate that these funds could be productively spent. The program plan for NASA that underlay the last budget submitted by President Bush would have required $3.8 billion by 1994 to carry out its agenda for space science. And even after decreasing the capability of the Earth Observation System and the Advanced X-Ray Astrophysics Facility (AXAF), the Administration's request for NASA for 1994 projected a budget for currently active programs of almost $3.5 billion by 1996. This alternative would support new large-scale missions under its $11 billion ceiling as the development of current projects--AXAF and the Cassini mission to Saturn--was completed and funds were shifted from scientific efforts necessary to extend human activities in space to more fundamental scientific enterprises.

This alternative does not directly address the "cheaper, better, quicker" criticism of shuttle-era space science. It would, however, permit the small space-science satellite programs already on the NASA agenda to go forward. Additional funding for the planetary exploration program would be sufficient to allow, for example, the development of the small Discovery missions now under discussion. Because the alternative would eliminate research directed toward major new propulsion systems and piloted spaceflight, the lower level of funds for space research and technology is adequate to continue research on small satellite systems.

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4. An example of a precursor mission is the U.S. Mars Environment Survey, which would land several small rovers on Mars by the turn of the century at an estimated cost of $1 billion. See Craig Covault, "Mars Strategy Begs for Direction," *Aviation Week and Space Technology*, October 5, 1992, pp. 25-26.

5. Cutting funds for operating technically healthy spacecraft is an issue that is now under discussion. See Leonard David, "Science Spacecraft May Be Threatened with Tight Budgets," *Space News*, June 28-July 11, 1993, p. 17.

CBO has assigned an arbitrary figure of $11 billion to fund the programs that would be supported under this alternative, but that total could vary between $10 billion and $12 billion, depending on how much piloted spaceflight was justified on strictly scientific grounds. This alternative would exclude the space station (with a budget of $2.1 billion in NASA's 1993 program) on the grounds that the project cannot be justified on its scientific contribution alone, a point that many space station supporters accept.[6] This alternative would limit piloted spaceflight to four shuttle flights annually.[7] Most of those flights would be devoted to spacelab missions in support of scientific activities in astrophysics, materials research, and Earth observation.[8] The justifications for supporting piloted spaceflight that apply in the first alternative--improving relations with Russia, influencing Russian policies on arms and technology sales, and preparing for future piloted exploration of the Moon or Mars--would not be applicable under this alternative.

The space science alternative includes some funding for piloted spaceflight, however--$4.0 billion, or 80 percent of the total funding provided for the space shuttle program in 1993. The budget to operate the shuttle would be reduced by slightly more than $200 million (anticipating four rather than eight flights per year).[9] The budget for shuttle production and operational capability funding would be reduced from $1 billion to $600 million by terminating most efforts to improve the shuttle system. A final $200 million reduction would come from the data and communications account as a consequence of eliminating piloted spaceflight. A space science agenda that includes piloted spaceflight for life science and experiments with microgravity materials does not permit additional reductions.

Technology and Space Science

The technology and space science alternative would concentrate resources in those areas in which tangible payoffs are most likely: developing technologies directed toward specific industries and space science activities with significant applications value. (Satellite programs that gather data for understanding global climate change are a primary example of the latter.) Adopting this alternative program would effectively end the current era of piloted spaceflight for the United States but would not preclude future piloted activities that relied on less expensive but as yet undeveloped launch and spacecraft technologies. NASA's budget would be cut to $7 billion, less than half the 1993 level.

This alternative attempts to make NASA's program more responsive to economic concerns and addresses the criticism that NASA's activities do not make a significant contribution to productivity in U.S. industry. Accordingly, the aeronautics budget would be set at $1.5 billion, an almost 75 percent increase over the 1993 level of $865 million. With this level of program funding, NASA could work actively with industry to develop the technologies necessary for future generations of both long- and short-haul aircraft. Reorienting NASA away from piloted spaceflight also would free up construction funds to reconstruct wind tunnels and improve other facilities that support aviation research. For example, funding for the National

6. D. Allan Bromley, Assistant to the President for Science and Technology, in his letter of March 11, 1991, to Vice President Dan Quayle includes an attachment entitled "Scientific Rationale for the Restructured Space Station." Bromley's statement is an example of the kind of argument for the space station that acknowledges that its scientific usefulness is confined to preparing for future piloted spaceflight. The letter portrays microgravity science and other potential applications of the space station as far too insignificant to justify the cost of the program.

7. Questions have been raised about whether the shuttle system can be safely operated at a flight rate of only four missions a year. If it was necessary to fly six missions annually, a number that most observers agree is within the margin of safety, the cost of the space science alternative would be greater than the $11 billion estimate by roughly $100 million.

8. The spacelab system includes pallets that carry experiments and instruments in the shuttle orbiter's payload bay and a modular laboratory that extends the habitable volume of the orbiter. The laboratory can be used for experiments in processing materials; the pallets carry instruments that are designed to look outward for physics and astronomy observations or back toward the Earth for Earth science observations.

9. This estimate of savings assumes that the marginal cost of a shuttle fight is $50 million. NASA puts this cost at $44 million. See General Accounting Office, *The Content and Uses of the Shuttle Cost Estimates* (January 1993), p. 8.

Aeronautics Facilities Upgrade, which decreased in NASA's 1995 budget request, could be maintained under this alternative.

Space research and technology, and commercial programs would be funded at $600 million, an increase over the combined 1993 funding of $435 million for these activities. Spending would be shifted within these programs toward technologies that had commercial potential and away from those that required piloted spaceflight.[10] This alternative would include a technology program to support the development of lower-cost, lightweight satellites for communications, remote sensing, and navigation. Funding would also be sufficient to aggressively pursue commercial-style purchases of data that would encourage innovative approaches to Earth observation. Programs to improve unmanned launch vehicles and facilities could also be funded under the technology and space science alternative.

The technology and space science alternative would encourage cost-sharing arrangements with industry to fund activities that directly benefited specific manufacturers or service providers. This part of NASA's program could also be used to cofund, with the Department of Defense, demonstrations of new approaches to fundamental problems of space activity--for example, supporting the single-stage-to-orbit rocket program. Support for the Landsat program might also be drawn from this account.

Funding in the space science area would be cut under this alternative to $2.1 billion, or about $700 million less than the 1993 level. Earth science activities would receive priority because they have the potential to generate data for environmental policy decisions as well as new scientific knowledge. The physics and astronomy and planetary explorations programs would be cut below 1993 levels. A part of that reduction and the general reduction in the space science area would come from cutting science activities that depended on piloted spaceflight, which in the 1993 program accounted for at least $400 million.

Ending piloted spaceflight would decrease spending for space transportation dramatically. The program outline for this alternative includes only $1.5 billion for the Space Flight, Control, and Data Communications activity that was funded at almost $5.1 billion in 1993. This funding would support the purchase of expendable launch vehicle services and tracking for space science missions.

Comparing Benefits

The choice of which program NASA should pursue in a constrained fiscal environment should depend on which program provides the greatest benefit relative to its cost and other uses of the same resources. Uncertainties, however, present major obstacles to that type of analysis. NASA's output is difficult to measure and value. The probability of the agency's actually achieving the objectives of a specific program is also difficult to evaluate.

This analysis does not solve the problem of valuing piloted spaceflight or scientific missions. But it illustrates that the often mentioned "balance" between piloted and unpiloted activity in the current NASA program is neither the only one possible nor necessarily the "best" approach.

As the second alternative to the current program shows, a set of activities that would provide a more rapid expansion of scientific knowledge can be pursued under a smaller total budget if piloted spaceflight is deemphasized. The difference in cost between the two options, however, indicates that to prefer the piloted spaceflight alternative to the space science option is to grant that the former would provide $3 billion more in annual benefits.

In a like manner, the third alternative outlines a NASA program with an even smaller annual budget

10. Microgravity materials processing--primarily growth of protein crystals--is the commercial prospect in the current program that would be lost under an alternative that did not include piloted spaceflight. The importance of this research to the private sector is minimal. Microgravity materials processing on its own is of insufficient value to justify piloted spaceflight but is an area worth exploring if piloted activities are being pursued. For a discussion of the industrial prospects for microgravity materials processing, see Congressional Budget Office, *Encouraging Private Investment in Space Activities* (February 1991), Chapter 4.

that focuses on developing technology useful to the aerospace industries and environmental monitoring to provide both worthwhile "pure" science and information necessary to support future environmental policymaking. The technology and space science alternative could achieve most of the scientific objectives included in the space science option because it does not bear the costly burden of piloted spaceflight. To prefer the piloted spaceflight option to the technology and space science alternative is to value the results of piloted spaceflight at $7 billion more each year compared with those associated with the technology and science alternative.

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